Intraluminal Stent Effects on Duplex Velocity Estimates

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Background: To measure changes in duplex velocity estimates associated with balloon expandable (BES) and self-expandable (SES) endoluminal stents.

Methods: An in vitro vascular circuit model consisting of a pulsatile pump, tubing, and a conduit was created. The pump was programmed to replicate the doppler spectral waveform pattern of the renal and carotid arteries. Conduits consisted of Sylgard® (Dow Corning, Midland, MI) tubing of variable compliance with differing wall thicknesses. An intraluminal fluid was created using a cornstarch and water mixture which had an average viscosity of 3.46 cP over the range of fluid velocities observed in this study. Pressure was measured continuously by electromechanical transducer at a site proximal to the conduit. Flow velocities were estimated with duplex ultrasound utilizing a matrix linear array probe at 6-15 MHZ (GE Logic E-9, GE Healthcare). Peak systolic velocity (PSV) and end-diastolic velocity (EDV) were estimated at 5 distinct conduit locations. Three replicate velocity measurements were made at each location. Diameter measurements of the conduit at peak systole and end diastole were made, and change in cross-sectional area calculated. After initial velocity estimates, a BES or SES was deployed within the conduit. Velocity estimates were then repeated. Three separate conduits were used. Analysis of PSV and EDV measured under the three arterial conditions (unstented, BES, and SES) was performed using mixed linear models that included a random effect to account for clustering. Fixed effects were included for condition, location (five segments marked on each conduit and denoted "A" - "E"), and replicate (1, 2, or 3). All analyses were performed using SAS version 9.2 software.

Results: Compliance was estimated for each conduit under each condition (unstented, BES, and SES). Values ranged from 3.12×10^{-3} to 8.43×10^{-3} mm^2/mm Hg. Average PSVs differed by condition. Mean ± SE PSV was 95.8 ± 2.6 cm/s, 97.0 ± 2.7 cm/s, and 101.4 ± 2.7 cm/s for unstented, BES and SES, respectively ($P < .0001$). Average PSVs differed significantly across location ($P < .0001$) and replicate ($P = .039$); however, no interaction between condition and either location or replicate were found. EDV values did not differ significantly across condition. Mean ± SE EDV was 36.2 ± 1.0 cm/s, 37.3 ± 1.1 cm/s, and 37.2 ± 1.1 cm/s for unstented, BES and SES, respectively ($P = .13$). Average EDVs differed significantly across location ($P = .001$) but not across replicates ($P = .82$). The direct effect of stenting on velocities was assessed by examining paired differences between the unstented and stented conduits calculated at each replicate. Mean ± SE percent change in PSV was −1.0 ± 3.3% for BES minus unstented, and 6.4 ± 3.1% for SES minus unstented ($P = .24$). Mean ± SE change in EDV was 1.3 ± 5.3% for BES minus unstented, and 3.5 ± 4.4% for SES minus unstented ($P = .79$). Overall estimates of the effect of stent placement (pooled across BES and SES types) were 3.7% (95% CI: −6.4%, 13.8%) for PSV, and 0.8% (95% CI: −7.1%, 8.3%) for EDV.

Conclusions: The presence of BES and SES were associated with a less than 7% change in estimated PSV. These results suggest that Doppler velocity estimates for renal and carotid arteries are not materially affected by either ballon expandable or self expandable endoluminal stents.

Hormone Replacement Therapy Influences Matrix Metalloproteinase Expression and Intimal Hyperplasia Development after Vascular Injury: A Follow-Up Study

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Background: Postmenopausal women taking hormone replacement therapy (HRT) have increased intimal hyperplasia (IH) following vascular intervention. Matrix metalloproteinases (MMPs) play a major role in IH development, and we have shown that hormone exposure results in unbalanced MMP regulation in vascular smooth muscle cells in vitro. Previously we presented data from a small pilot study suggesting a role for HRT in the development of IH via MMP modulation in vivo, using a postmenopausal rodent model of vascular injury. Here we further investigated the role of HRT as a modulator of MMPs and IH in a larger follow-up study.

Methods: Female rats were aged to 12 months and ovariectomized (OVX). Four weeks later estrogen (E), progesterone (P), estrogen + progesterone (E/P), or placebo (Plac) were delivered via 90-day slow-release pellets. Following 6 weeks of HRT, each rat underwent balloon angioplasty of the left common carotid artery. At 14 days postinjury, tissue samples were collected and stained with Trichrome elastin for intima:media (I:M) measurement and stained for various MMP isoforms.

Results: Following vascular injury I:M was decreased in OVX rats compared to non-OVX controls (Fig 1, n = 5-6, P = NS). In OVX animals, HRT exposure did not significantly increase the I:M ratios. (Fig 1, n = 5-6, P = NS). Injury-induced expression of MMP-2 and −9 was significantly decreased in OVX animals compared to non-OVX controls (Table 1; n = 5-6). MMP-2 and −9 levels were subsequently increased by each type of hormone therapy compared to placebo, with a significant increase in MMP-9 in response to estrogen with and without progesterone (Table; n = 5-6). Conversely, TIMP-2 was significantly decreased by estrogen compared to placebo (Table; n = 5-6). There was no effect on intimal MT1-MMP in any group.

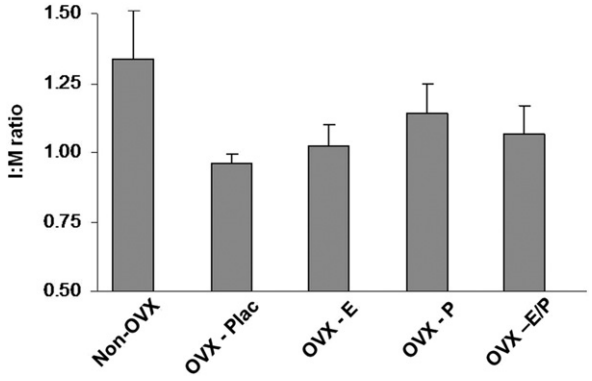

Table 1.

	% intima stained				
	NonOVX C	*OVX - Plac*	*OVX - E*	*OVX - P*	*OVX - EP*
MMP-2	37.8 ± 10.0	15.4 ± 3.7*	26.5 ± 3.7	38.8 ± 7.6	38.5 ± 7.6
MMP-9	4.3 ± 0.1	2.7 ± 0.4*	4.7 ± 0.6#	6.0 ± 1.3	7.1 ± 1.0#
TIMP-2	50.9 ± 8.9	22.2 ± 3.4*	8.7 ± 1.4#	24.8 ± 10.1	28.2 ± 9.4

*P < 0.05 vs. NonOVX C
#P < 0.05 vs. OVX-Plac

Conclusions: Here we were not able to demonstrate a statistically significant decrease in IH as a result of ovariectomy. Furthermore, HRT at the doses given did not remarkably increase IH. Here we also demonstrate a significant reduction in MMP-2, −9, and TIMP-2 in response to ovariectomy. Subsequent hormone exposure results in the upregulation of MMP-2 and −9 without a counter-regulatory increase in TIMP. We have previously shown elevation in MT1-MMP to occur during the initial phases of IH development; therefore, examination earlier than 14 days postinjury is needed to determine the effect of HRT on this MMP regulatory isoform. Future studies should investigate in vivo manipulation of this unbalanced MMP regulation for prevention of IH in response to HRT exposure.

National Trends in Repair of Intact Abdominal Aortic Aneurysms in the Medicare Population

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Background: Endovascular abdominal aortic aneurysm repair (EVAR) of intact abdominal aortic aneurysm (AAA) continues to gain favor despite the perceived higher procedural costs when compared to open repair (OPEN). National trends in AAA repair are unknown. This study aims to compare regional utilization of EVAR, and its effects on patient mortality and procedural costs.

Methods: All patients in the Medicare database who underwent AAA repair from 2004 to 2007 were identified and stratified into OPEN and EVAR cohorts. Geographic regions were created according to standard US census divisions. Primary outcomes included perioperative mortality, long-term survival and hospital cost.

Results: There were 103,033 patients identified, 68,370 EVAR (66.4%) vs 34,6633 OPEN (33.6%). Although EVAR is favored nationally, there are significant differences in regional utilization (Table). Between 2004 and 2007, the total number of AAA repairs was not different (25,246 vs 25,850, P = NS), but the percentage of EVARS performed was significantly higher in 2007 (14,001 [55%] vs 19,471 [75%], $P < .001$). The national 30-day mortality was significantly higher after OPEN (4.9% vs 1.6%, $P < .001$), however, long-term survival was equal(73.6% OPEN vs 74.6% EVAR $P = .04$) with no regional differences (Table). Hospital charges for EVAR were significantly less than open ($64,380 EVAR vs $68,174 OPEN, $P < .0001$), as was Medicare reimbursement ($19,367 EVAR vs $23,474 OPEN, $P < .001$). This is likely due to an increased length-of-stay in the OPEN cohort (3.5 days EVAR vs 9.9 days OPEN, $P < .001$)

Conclusions: Despite a constant number of yearly intact AAA repair, national EVAR utilization increased over the study period. Perioperative mortality was lower after EVAR but there was no difference in long-term survival and no regional differences in mortality for either cohort. In addition, EVAR was performed with a lower hospital cost than OPEN. This large national study further supports the use of EVAR as the first-line therapy for intact AAA.

		Midwest	*Northeast*	*South*	*West*	*National*
Number of patients	OPEN	10,195	6175	13,571	4722	34,663
	EVAR	18,433	13,012	28,102	8,823	68,370
	%EVAR	64.4%	67.8%	67.4%	65.1%	66.4%
		$P > .001$				
30-mortality	OPEN	4.9%	4.8%	5.0%	4.6%	4.9%
	EVAR	2.6%	1.9%	2.4%	2.5%	1.6%
		$P > .001$ (OPEN vs EVAR)				
5-year survival	OPEN	74.4%	73.8%	72.7%	74.1%	73.6%
	EVAR	75.5%	73.6%	74.1%	75.3%	74.6%
		($P = .4$ for OPEN vs EVAR, $P = .9$ for regions)				

Randomized Clinical Trial of Open-Cell vs Closed-Cell Stents for Carotid Stenting: Effects of Stent Design on Cerebral Embolization

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Background: The effect of stent design on cerebral embolization has not been established. The purpose of this trial was to contrast the incidence of cerebral embolization in high-risk patients undergoing carotid artery stenting (CAS) with open-cell vs closed-cell stents.

Methods: During an 18-month period, 40 patients were randomized (1:1) to undergo CAS with open-cell (Acculink, n = 20) or closed-cell stents (Xact, n = 20). A single filter device for embolic protection (Accunet filter) was used. Transcranial Doppler (TCD)-detected microembolic signals (MES) during CAS and pre- and 24-hour postprocedural diffusion-weighted magnetic resonance imaging (DW-MRI) were used to determine cerebral embolization. Univariate and nonparametric analyses were used to assess associations between stent design and cerebral embolization.

Results: CAS was performed in 16 (41%) symptomatic and 24 (59%) asymptomatic patients with equal number of open-cell and closed-cell stents (8/8 and 12/12, respectively). The total and poststenting median MES counts detected by TCD were 225 (interquartile range [IQR], 191-257) and 59 (IQR, 43-123) for open-cell stents and 281 (IQR, 134-372) and 74 (IQR, 41-88) for closed-cell stents, respectively ($P = .4$). New acute cerebral emboli detected with DW-MRI occurred in 47% and 53% of patients undergoing CAS with open-cell and closed-cell stents, respectively ($P = .9$). The total and ipsilateral median number of DW-MRI lesions between groups were not statistically significantly different, ie, 1.5 (IQR, 0-3.75) and 1 (IQR, 0-2) for open-cell stents and 2 (IQR, 0-3) and 1 (IQR, 0-3) for closed cell-stents, respectively ($P = .7$). One asymptomatic patient undergoing CAS with an open-cell stent sustained a minor stroke; the 30-day stroke-death rate in this series was 2.5%.

Conclusions: Cerebral embolization, as detected by TCD and DW-MRI, occurs with similar frequency after CAS with open-cell and closed-cell stents. This randomized trial does not support the superiority of any stent design with respect to cerebral embolization.

Timing of Venous Thromboembolism After Colorectal Cancer Resection

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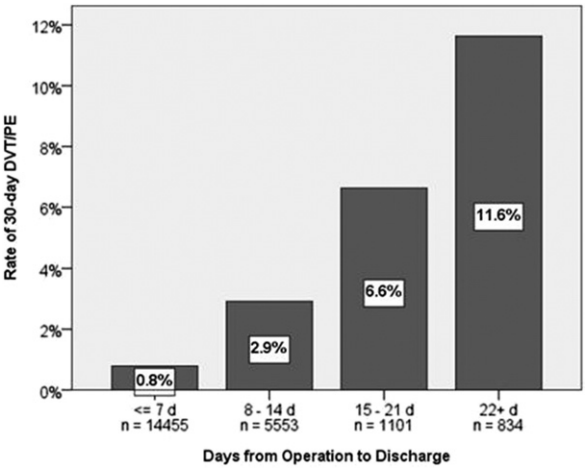
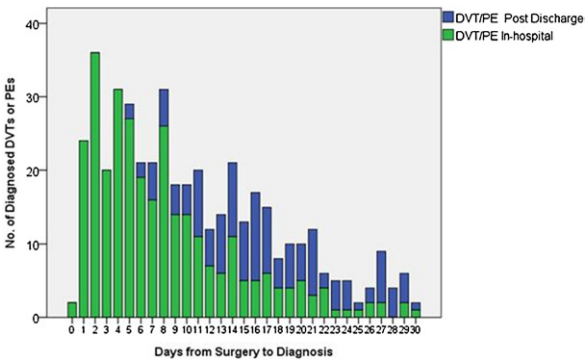
Background: Deep vein thrombosis (DVT) and pulmonary embolism (PE) are significant sources of postoperative morbidity and mortality and are currently major quality improvement initiatives. Mechanical and pharmacological prophylaxis is effective in preventing postoperative thromboembolic events, thromboprophylaxis is usually discontinued after discharge. We postulated that patients may still be at risk of venous thromboembolic disease (VTE) after discharge and and tested this hypothesis in patients undergoing colorectal resection for cancer, a high-risk population.

Methods: The ACS NSQIP database was queried for patients undergoing colorectal resections for cancer based on the primary procedure CPT code and operative ICD-9 diagnosis code from 2005 to 2008. The outcome analyzed was 30-day DVT and/or PE. DVT/PE occurrences were analyzed by postoperative day, rate relative to hospital length of stay, and by whether they occurred in-hospital or after initial discharge. Multivariable forward stepwise regression (P for entry $< .05$, for exit $> .10$) was used to identify independent predictors of DVT.

Results: The database contained 21,943 colorectal cancer resections. DVT/PE (both inpatient and outpatient) rates increased linearly from 0.8% in patients with length of stay (LOS) less than 1 week to 11.6% in patients with LOS greater than 3 weeks (χ^2 test for linear trend, $P < .001$, Fig 1). The DVT rate was 1.4% (306/21,943) of which 29% (89/306) were diagnosed post discharge. The PE rate 0.8% (180/21,943) of which 33% (60/180) were diagnosed post discharge. Patients were diagnosed with both only 40 times and the combined DVT or PE rate was 2.0% (446/21,943). The ratio of outpatient to inpatient VTE rate as related to days that elapsed from the surgical procedure is shown in Figure 2. Independent risk factors for postdischarge DVT/PE were preoperative steroid use for chronic condition (n = 575, odds ratio 2.90, 95% CI 1.51-5.57, P = .001) and preoperative systemic inflammatory response syndrome (n = 875, odds ratio 2.26, 95% CI 1.24-4.10, $P = .008$)

Conclusions: Analysis of the NSQIP database shows increasing rates of VTE as hospital LOS increases. It was surprising to find that diagnosis of almost 1/3 of postoperative VTE in this patient population occurs after discharge. The duration of the prothrombotic stimulus of surgery is not well defined and patients with malignancy are at high risk of VTE. It is conceivable that thromboprophylaxis after discharge should be considered for these patients. Additional studies may identify other patient groups in similar risk.





Diastolic Function Predicts Survival After Renal Revascularization

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Background: To define the relationship between left ventricular diastolic function and survival after renal revascularization.

Methods: Seventy-six adult patients (49 women, 27 men; mean age: 63 years ± 13 years) with preoperative echocardiography who underwent renal revascularization for atherosclerotic disease were identified. Echocardiograms were performed and interpreted according to American Society of Echocardiography Recommendations for Use of Echocardiography in Clinical Trials. Diastolic function was estimated by measuring the early diastolic